A CRITICAL REVIEW OF BEACH RESTORATIONS PROJECTS IN THE NORTHERN COAST OF CADIZ (SPAIN) AFTER THIRTEEN YEARS

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The main purpose of this paper is to present a critical review of different beach restoration projects conducted since 1992 till today at the northern coast of Cadiz (Chipiona and Rota counties) by analyzing the different coastal engineering and coastal management considerations used in their design. In particular, four different cases of beach nourishment projects are analyzed, having each one specific and interesting points to be stressed : a) Regla beach nourishment project ; b) Rota beach nourishment project; c) Punta Candor dune restoration project ; and d) La Ballena nourishment project.

INTRODUCTION

The northern coast of Cadiz (Rota and Chipiona counties) presents a variety of coastal engineering and coastal management problems whose solution is not an easy task due to the complexity of the following parameters involved : beach morphodynamics due to the presence of reef areas ; high dune erosion rates (0.5-1 m retreat per year) ; existence of environmental rich rocky areas to be preserved from beach nourishment projects ; location of still preserved dunes under natural geological erosion ; urbanization and dune occupation prior to the Spanish Shore Act approval in 1988 ; high tourist development under an eroded coastline ; at present almost null possibility of using the only known high quality sand borrow area, successfully used thirteen years ago, due to the radical opposition of local fishermen ; impressive presence of the “corrales”, a kind of stoned man-made ponds, built from the Roman times, acting as a fishing pond as well as a protective semi-submerged breakwater under a 3.5 m tidal range.

OBJECTIVE

The main purpose of this paper is to present a critical review of four different beach restoration projects carried out at the northern coast of Cadiz

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(Chipiona and Rota counties) since 1992, by analyzing the different coastal engineering and coastal management considerations used in their design.

The first two restoration projects, corresponding to the beaches of Regla and La Costilla (Co. Chipiona and Rota, respectively) were undertaken in 1992 and 1993. They both used sand from two marine borrow areas, unable to be used today for different reasons. They also incorporated a terminal groin as part of the design scheme. The following aspects were incorporated into the beach restoration scheme, according to Gómez-Pina 2005, 2006 : i) Technical ; ii) Environmental; iii) Constructive; iv) Economical; v) Aesthetic; vi) Recreational; vii) Safety; viii) Navigational. These aspects were not analyzed independently due to the connections between them. The sustainability concept in the whole design was also considered.

WAVE CLIMATE AND LITTORAL TRANSPORT ASSESSMENT

Fig.1 shows a wave rose superimposed to an aerial photograph of the northwestern coastline of Cadiz. The main swell waves are from the western direction. The values for significant wave height (H_s) an for wave period, obtained for a deepwater average yearly wave regime, are : Hs = 2.5 m, T_p= 12 s. Maximum tidal range is 3.5 m. An estimation of littoral transport was evaluated in Muñoz-Pérez and Enríquez, 1998. Littoral transport rates are changing from Regla beach (almost null), La Ballena beach (15.000 m^3/y), and Punta Candor (20.000-30.000 m^3/y), with a net transport towards the NW direction. The same authors found important coastline retreat values by using comparative aerial photographs. In some places the retreat ratio was as high as 1.5 m/yr.

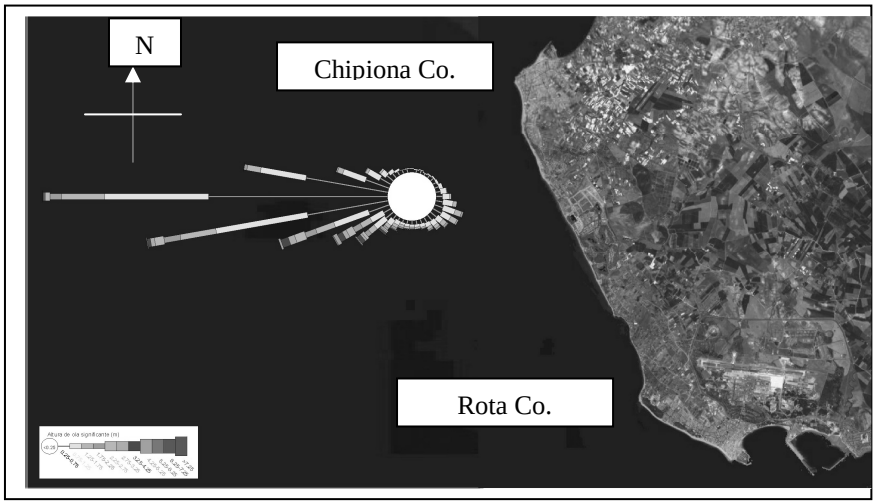

Figure 1.- Aerial photograph of the Northwestern coastline of Cadiz and

REGLA BEACH RESTORATION PROJECT (Chipiona Co.)

The historical evolution of Regla beach runs parallel to most of the beaches in Spain till the 1988 Spanish Shore Act was approved and strict delimitation of the land- maritime public domain was undertaken. Fig. 2 shows a southern view of Regla beach quite different from today. Only two buildings can be seen at this time: the Sanatorium and the Virgin of Regla Catholic Monastery (the most important historical monument in Chipiona). A well preserved high dune system can be observed without any building occupation.

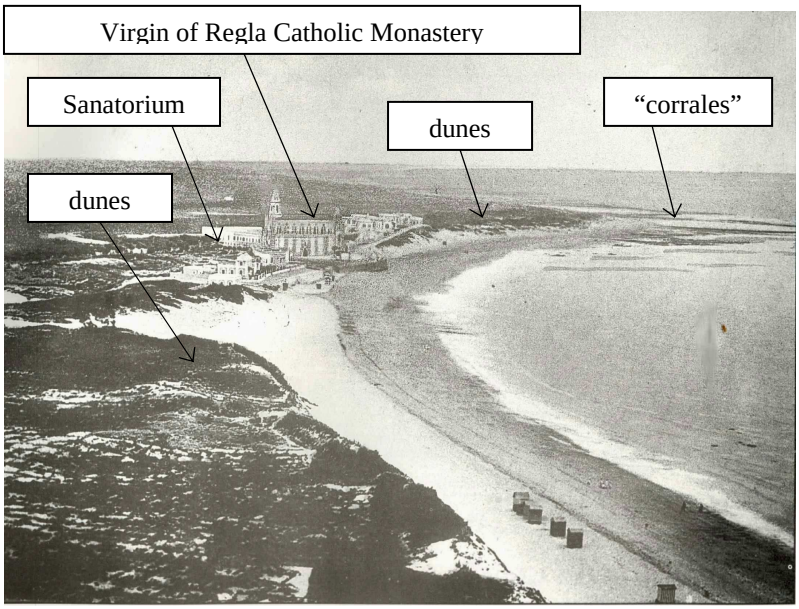

Figure. 2. Southern view of Regla beach (Chipiona Co.) at low tide in the 30´s (Source : Naval´s photograph collection).

The following morphodynamics aspects are important for this particular beach restoration project : i) Existence of a wide rocky area at the northern part of the beach, in front of the Chipiona lighthouse (another important referential monument); ii) almost no beach at daily high tide (3.5 m max. tidal range); iii) a salient of the existing waterfront in front of the Virgin of Regla Monastery; iv) existence of another wide rocky area, acting as a parallel submerged reef at the southern part of the beach. A relatively well preserved dune system is found in front of this area.

Figures 3 and 4, taken by Gómez-Pina in 1991, show an almost non-existent dry beach at daily high tide.

Figure. 3. Northern view of Regla beach (Chipiona Co.) at high tide in 1991, prior to beach restoration (Source: Gómez-Pina´s photograph collection,).

Figure. 4. Southern view of Regla beach (Chipiona Co.) at high tide in 1991, prior to beach restoration (Source: Gómez-Pina´s photograph collection),

From a technical point of view it was considered necessary to design a terminal groin at the northern part of the beach to hold the beach fill (500.000 m^3 along 1540 m). Both subaerial and toe profile parts were laterally held by this terminal groin (Fig. 5). This terminal groin had a positive environmental impact within the beach nourishment project since was designed to prevent the nourished sand from invading the adjacent ecologically rich, rocky area in front of the Chipiona lighthouse.

This coastal groin had the minimum visual intrusion regarding crest width and height. Besides fulfilling technical and environmental aspects, this terminal groin was designed to enhance local fishing by imitating the ancient, local "corrales" which were artificial fishing ponds from Roman times designed to trap fish by taking advantage of the 3.5 m local tidal range.

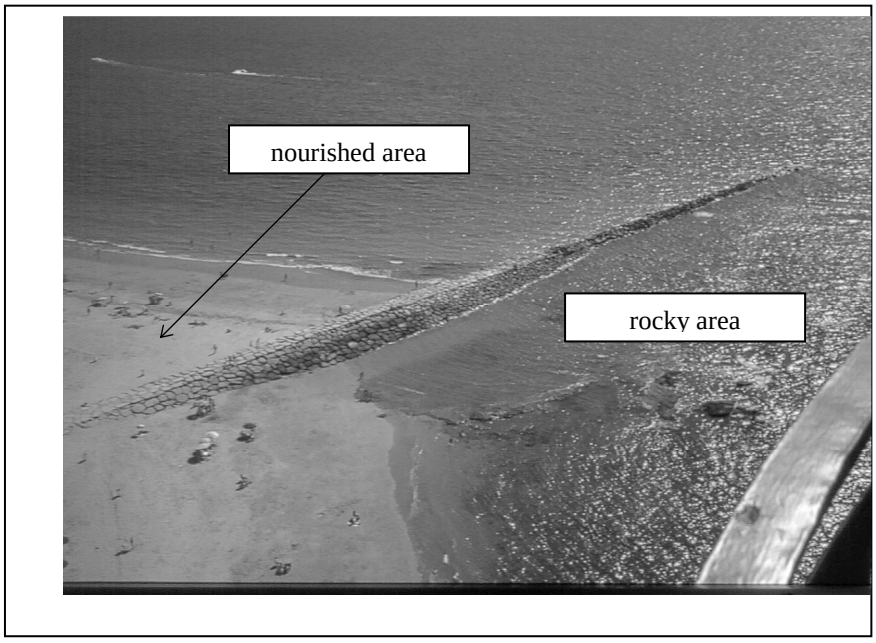

Figure.5. View of an aesthetic and well-integrated terminal coastal groin at Regla beach nourishment project , Chipiona Co. (Source (Gómez-Pina, 2004)

Fig. 6 shows an aerial view of Regla beach after restoration

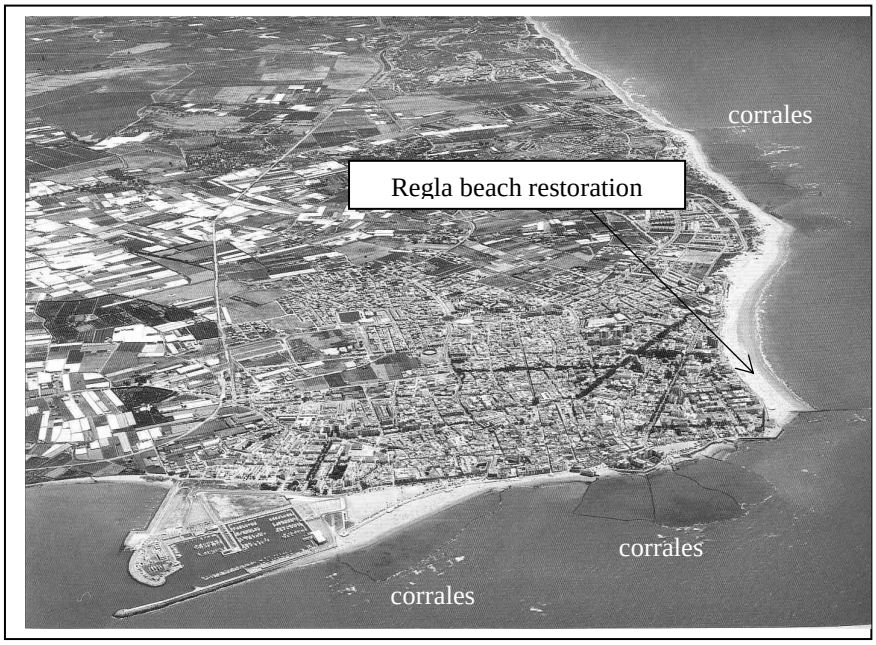

Figure 6 View of Regla beach (Chipiona Co.) restoration project after completion (Source : Spanish National Coastal Authority)

LA COSTILLA BEACH RESTORATION PROJECT (Rota Co.)

The project consisted of adding 360.000 m3 of sand (D_{50} = 0.40 mm), along 1350 m, from the dredging of the Cadiz harbor channel, together with the enlargement of a submerged part of an existing old terminal groin. This beach nourishment project was completed with a beautiful waterfront in the back of the beach.

An interesting aspect of this beach restoration project was the revitalization of the old existing terminal groin to be used as an extension of the waterfront, enhancing the existing recreational and social uses of the beach (for instance, fishing, beach walking). Also, a submerged groin was added to hold laterally the submerged part of the nourished profile.

Fig. 7 depicts an aerial view of La Costilla beach restoration project. Fig. 8 is a detail of the beach and waterfront integration.

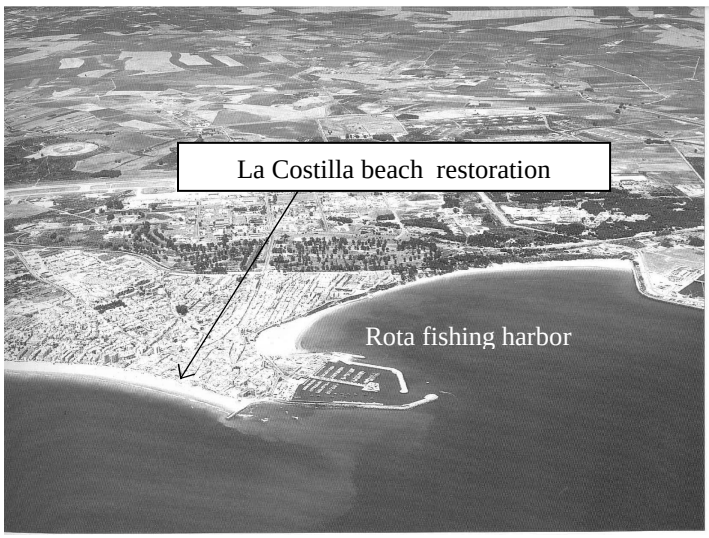

Figure. 7. Arial view of the southern part of La Costilla beach restoration project, Rota Co. (Source: Spanish National Coastal Authority)

Figure.8 A good example of beach and waterfront integration in La Costilla beach, Rota Co. (Source: Gómez-Pina´s photograph collection).